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Contribution of Fall-Stocked Brown Trout to a Winter Fishery: A Comparison of Trout Stocked in October and December

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ABSTRACT

Over a three year period, four study waters received half their stocking allocation of fall yearling brown trout (*Salmo trutta*) in December, approximately seven weeks later than traditionally stocked (October); the other half was stocked in October. The trout were differentially fin clipped by year and month stocked to facilitate future identification in the field. The author hypothesized that lower survival (due to increased predation and emigration) and resulting contribution to the fishery may be attributed to spawning related behaviors (e.g., movement inshore, use of inlets/outlets) associated with stocking sexually mature hatchery trout that are not yet predator savvy during the brown trout spawning season in October. The contribution of each stocking to the recreational fishery was assessed using several fish collection methods, including a roving clerk survey (winter), gill nets (summer), and trap nets (fall). Brown trout data collection proved challenging on all study ponds, except for Sabbathday Lake where a robust sample provided a high confidence in the analysis. Mean angler party harvest rates on Sabbathday Lake were 1.5 times higher for December-stocked trout (0.017 legal brown trout per hour) than October-stocked trout (0.011 legal brown trout per hour) and this difference was statistically significant (Wilcoxon Rank sum, 2-sided, p=0.0174). An examination of age classes present in the harvest revealed a higher percentage of each cohort was comprised of December-stocked fish; on average 39% more holdovers were December-stocked trout. December-stocked trout also contributed 25% more to the harvest of oldest and largest brown trout, and this increase was also found to be statistically significant (X^2=33.802, 1 d.f.; 2 sided p<0.0001). Time of stocking did not appear to influence angler harvest opportunity on Crystal Lake and could not be assessed on Middle and Upper Range ponds due to insufficient data.

KEY WORDS: BNT, PREDATION, STOCKED TROUT, RETURNS, CPUE, ANGLER SURVEY, RECRUITMENT

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SUMMARY

Fall yearling brown trout, 12 to 14 inches in length, are stocked annually in Maine lakes and ponds to create year-round recreational fishing opportunities where indigenous salmonids do not perform well. These lake-stocked brown trout are typically released at a size below the minimum legal harvest length of 14 inches, with the expectation of post stocking survival and growth to create a multi-age class fishery.

Hatchery personnel at the New Gloucester Hatchery report the vast majority of fall yearling brown trout (age I+) are sexually mature at time of stocking. Not surprisingly, pre-spawn, post-stocked brown trout often concentrate in areas of shallow moving water (inlets/outlet) in preparation for spawning. Furthermore, staff biologists have observed injuries to recently stocked trout captured in fall-set trap nets, including visual observations of nearby fish predators. It was hypothesized that a delay in stocking until after the urge to spawn had lapsed would reduce shallow water swimming behavior, reducing their susceptibility to predation and loss from the fishery. Lake-stocked brown trout are typically released in October, but over a three year period on four study waters half the scheduled stockings were planted in October and the remaining half released in December. Trout associated with each stocking were differentially marked (fin clipped) to support field identification and comparison.

Brown trout survival and recruitment to the fishery were evaluated using recreational angler harvest data collected during the month of January over three consecutive years (2008, 2009, and 2010) on Sabbathday and Crystal lakes. A robust sample obtained from Sabbathday Lake (n^{fish}=130) and a smaller sample obtained from Crystal Lake (n^{fish}=29) supported detailed analysis for this investigation. Brown trout data collected during this investigation was incidental to data collected during a statewide assessment of catchable brook trout.

Two other waters included in this investigation (Middle and Upper Range ponds) were sampled with gill nets and trap nets in 2009 and 2010. In addition, an abbreviated angler survey was conducted in January of 2010 to increase sample size. These efforts yielded a small sample (Middle Range: n^{fish}=4, Upper Range: n^{fish}=5) - unsuitable for statistical analysis but they are included in this report nonetheless.

A total of 179 study brown trout were examined across all four study waters and data collection methods. Seventy three percent of the total sample was collected on Sabbathday Lake; 59% originated from the December stocking and 41% originated from the October stocking.

On Sabbathday Lake mean angler party harvest rates for December-stocked trout (0.017 legal brown trout per hour, $n^{angler\ interviews}$ =448) were 1.5 times higher than October-stocked trout

(0.011 legal brown trout per hour, $n^{\text{angler interviews}}$ =448). This difference was statistically significant (Wilcoxon Rank sum, 2-sided, p=0.0174). An examination of age classes present in the harvest revealed a higher percentage of each cohort was comprised of December-stocked fish; on average, 39% more holdovers were December-stocked trout. December-stocked trout contributed 25% more to the harvest of three and four year old brown trout, which are the oldest and largest in the fishery. This difference was also found to be statistically significant (X^2=33.802, 1 d.f.; 2 sided p<0.0001).

No statistically significant differences reflecting month stocked were found on Crystal Lake, although a relatively small sample size reduced confidence in the analysis. Physical differences in lake hydrology and attraction flows may have influenced the vulnerability of newly-stocked brown trout to predation and out migration, and may have accounted for differing results on Sabbathday and Crystal lakes.

INTRODUCTION

Brown trout (*Salmo trutta*) are not native to Maine, but are propagated and typically stocked in waters unable to support desirable fisheries for stocked or wild indigenous salmonids, including brook trout (*Salvelinus fontinalis*) and landlocked Atlantic salmon (*Salmo salar*). Factors limiting performance of indigenous salmonids include environmental conditions (e.g., summer water quality) and/or biological constraints (e.g., interspecific competition, predation, forage, and limited spawning and nursery habitat). These same factors typically create conditions less than ideal for brown trout, although brown trout can tolerate a broader range of biological and environmental conditions than indigenous salmonids (Raleigh et al. 1986, Raleigh 1982, and Marcus 1984).

In 2013, brown trout accounted for 12.7% of all state hatchery fish production in Maine. A total of 147,965 hatchery brown trout were stocked as spring yearlings (8.3-9.8 in) and fall yearlings (10.9-13.1 in), accounting for 44% and 43% of the stocked brown trout, respectively.

Warner (1972) documented significant predation by chain pickerel (*Esox niger*), smallmouth bass (*Micropterus dolomieu*), and largemouth bass (*Micropterus salmoides*) on smaller spring yearling landlocked salmon. One common strategy employed by managers to increase post-stocking survival of stocked salmonids, where threats from piscivorous, mammalian, and avian predation are a concern, is to stock larger fall yearling hatchery trout, particularly in lakes and ponds.

There is a concern among Maine Department of Inland Fisheries and Wildlife (MDIFW) biologists with experience managing brown trout that fishing quality for stocked brown trout has declined, and at best has provided inconsistent fishing over the past decade. Past attempts by this author to quantify and compare historical catch rates with current rates were complicated by variable regulations, hatchery product size and quality, fish community composition, management goals/objectives, and environmental conditions. Consequently, a decline in brown trout fishing quality remains an undocumented management concern.

However, one recent investigation in Maine provides some relative performance information. The investigation documented year-round angler returns of stocked rainbow (*Oncorhynchus mykiss*) and brown trout on five lakes (Pellerin 2007). On average, 21.8% of the stocked browns were returned to anglers as legal catch. By comparison, stocked rainbows offered a legal return rate exceeding 100% (as a result of angler catch and release practices). Also, legal-size brown trout were caught 4.3 times more frequently during the open water fishing season than the ice fishing season. The lower relative catch and seasonal vulnerability to angling may be a trait that encourages brown trout survival to create multi-age fisheries, particularly in smaller lakes and ponds supporting relatively high angling use.

Maine's current statewide Brown Trout Management Plan (Boland 2001) identifies abundance, catch rate, and size quality objectives for lacustrine, riverine, and tidal waters supporting brown trout fisheries. Plan objectives for lakes and ponds imply some post-stocking survival through at least one year at large or longer, growth that reaches or exceeds the legal length limit (12-inch minimum length prior to 2007 and 14 inches thereafter) after one year at large, and the development of a multi-age/size class fishery providing opportunity to catch 18-20 inch brown trout. The current minimum length limit of 14 inches encourages escapement and growth of fall-stocked age I+ brown trout on most lakes and ponds, which are generally not of legal size at the time of stocking.

A high priority research need identified in the 2001 plan relates to the influence of genetics on post-stocking survival. Genetic testing of Maine's New Gloucester brown trout strain indicated a high degree of homogeneity (Leary 1999). A loss of genetic variability may explain, in part, changes (real or perceived) in brown trout field performance. Two new strains of brown trout (Sandwich and Seeforellen) are currently being field tested in Maine. However, we hypothesize that factors other than genetics may also influence brown trout field performance, including stocking practices. This latter factor is the subject of this investigation.

Fall yearling brown trout are nearly two years old at the time of stocking. At lengths approaching 13 inches, most males and many females are sexually mature at this age, as evidenced by milt and eggs expressed when these fish are handled in the hatchery (Tim Knedler, personal communication). Captive brown trout brood retained at New Gloucester State Fish Hatchery are, on average, stripped on October 18th[1], a date which presumably represents the time when stocked browns are expressing spawning-related behaviors, including attraction to shallow, flowing water. The onset of sexual maturity and the spawning season coincides with the timing of fall stocking (typically October). It's possible that behavioral changes associated with spawning may predispose newly stocked trout to increased predation. Field observations suggest recently stocked fall yearling brown trout migrate to areas of flowing water often associated with very small (even ephemeral) tributaries. This phenomenon has been observed by field biologists tending trap nets set along the shoreline in the vicinity of tributaries to capture older age browns and other salmonids, commonly resulting in heavy captures of recent releases. It is common practice for biologists to request postponement of hatchery stocking until completion of netting operations to avoid handling stress and injury to newly stocked trout. Furthermore, it is not uncommon to observe fresh injuries (tooth marks from mammalian predators, talon puncture wounds from avian predators) on recently stocked trout. Post-stocking movement and concentration of newly stocked, not yet "predator savvy" trout in these shallow water areas may increase their vulnerability to predation. The stocking of larger fall yearling brown trout as a strategy to reduce predation from warmwater fish predators may have increased predation opportunity for other types of piscivores.

This investigation was initiated to determine if stocking later in the fall would increase survival and recruitment of stocked brown trout to the winter recreational fishery. We hypothesized that spawning-related behaviors would subside by December (a few weeks prior to freeze up), and stocking at this time might reduce predation losses, thereby enhancing recruitment of stocked brown trout to the sport fishery. Stocking later may also reduce the incidence of out migration via inlets and outlets, although an assessment of this potential loss was beyond the scope of this investigation.

[1] Spawning dates compiled by Tim Knedler, representing the last 16 years of egg take.

STUDY AREA

Study waters (Figure 1) were selected in close proximity to the regional headquarters in Gray to ensure data collection compatibility with other ongoing investigations. Four waters were included in this investigation: Crystal Lake (Gray), Sabbathday Lake (New Gloucester), Middle Range Pond (Poland), and Upper Range Pond (Poland). A brief description of each study water is provided below.

Sabbathday Lake (New Gloucester) provides unusually good forage fish and water quality for brown trout. Suitable late summer water quality extends well below the thermocline, with an oxygen deficiency limited to only the deepest depths of this 68-foot deep, 340-acre mesotrophic lake. An abundant rainbow smelt (*Osmerus mordax*) population provides excellent forage for stocked brown trout and also supports a popular spring dip net and winter hook and line fishery. An annual hatchery stocking program maintains cold water fisheries comprised of brook and brown trout. A total of 350 fall yearling brown trout are stocked annually to seed the development of a multi-age class fishery. Approximately 500 spring yearling brook trout are also stocked with little expectation of survival beyond the first open water season at large, although some contribution to the following winter fishery has been documented. Fall yearling brook trout (510) were stocked annually throughout this investigation to enhance winter angling as part of an experimental statewide catchable trout study conducted concurrently with this investigation. A small number of retired brook trout brood was also stocked when available. Both largemouth and smallmouth bass are present, although largemouth bass are more abundant and dominate the bass fishery. Other fish species present include: chain pickerel, white sucker (*Catostomus commersoni*), black crappie (*Pomoxis nigromaculatus*), brown bullhead (*Ameirus nebulosus*), American eel (*Anguilla rostrata*), pumpkinseed sunfish (*Lepomis gibbosus*), and various minnow species (*Cyprinidae & Fundulidae).* Brown trout, brook trout, rainbow smelt, and largemouth bass provide principal recreational fisheries. Two perennial inlets and an unregulated perennial outlet create attraction flows and outmigration pathways for sexually mature adult brown trout searching for spawning habitat in the fall.

At 189 acres, Crystal Lake (Gray) is the smallest study water included in this investigation. Late summer water quality is suitable for brown trout, but an oxygen deficiency develops below the thermocline in this 59-foot deep mesotrophic pond. Water quality and forage are less suitable than on Sabbathday Lake and Middle Range Pond. Landlocked alewives (*Alosa pseudoharengus*) were introduced in Crystal in 1984 as alternative forage to compensate for a declining smelt population. Hatchery stocking programs maintain cold water fisheries for brown, brook, and rainbow trout. Fall yearling browns (250) and fall yearling rainbows (250) are stocked annually to sustain multi-age class fisheries for both species. In addition, 285 fall yearling brook trout have been stocked throughout this investigation to enhance winter angling, as part of a concurrent statewide catchable trout study. More recent illegal introductions of brown bullhead and yellow perch (*Perca flavescens*) have compromised management for coldwater fisheries on Crystal Lake.

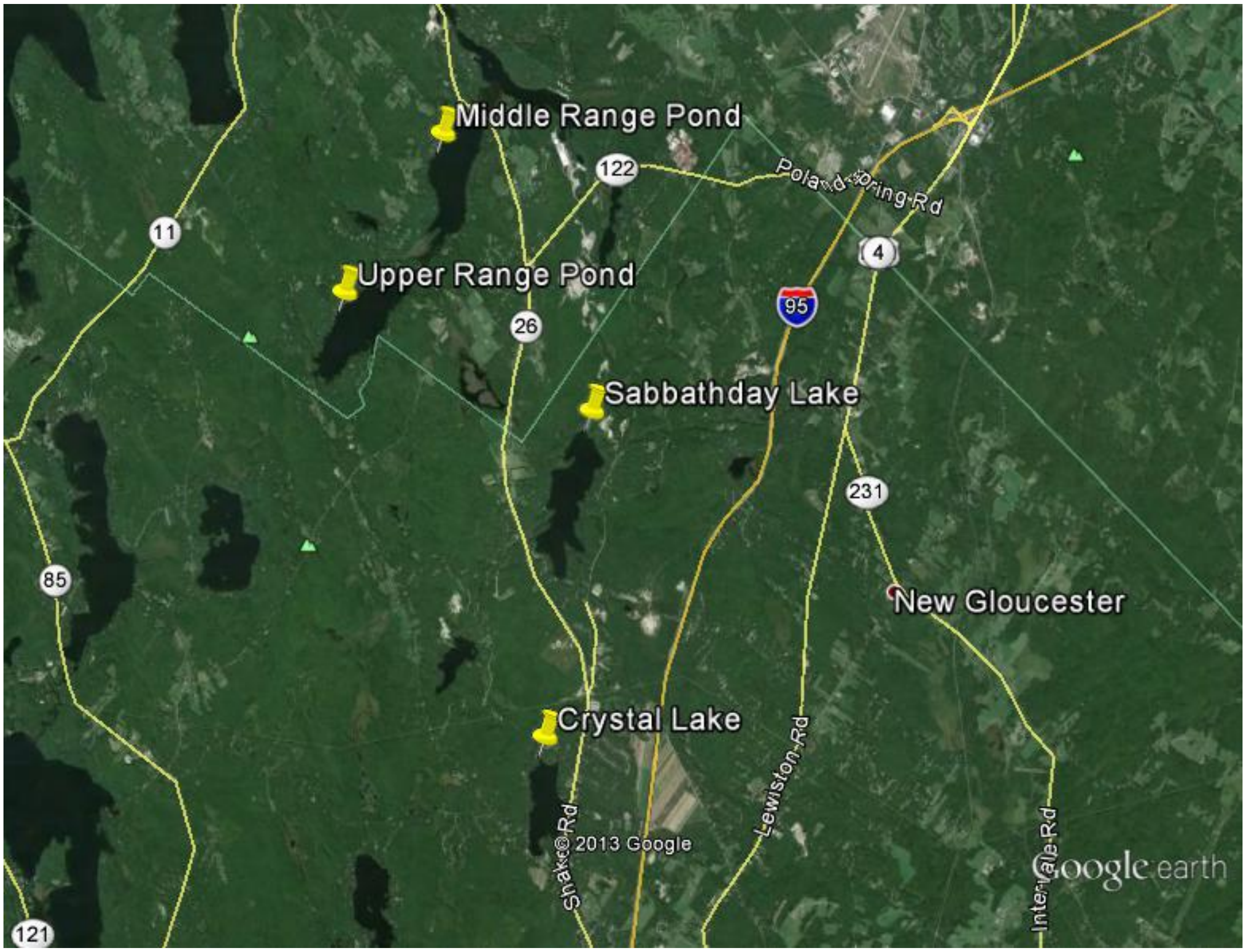

Figure 1. Google Earth Image of Study Water Locations

Other self-sustaining fish populations present include: rainbow smelt, largemouth bass, chain pickerel, pumpkinseed sunfish, white sucker, American eel, and minnow species. Rainbow trout, brown trout, and brook trout provide principal recreational fisheries. A short, intermittent inlet and intermittent natural outlet offer little attraction to spawning adult brown trout and limited opportunity for out-migration. This lake resides in well-drained sand and gravel aquifer and its hydrologic characteristics appear to be more strongly influenced by groundwater levels than by surficial input associated with individual precipitation events.

Middle (366 acres) and Upper Range (391 acres) Ponds lie to the north of Sabbathday Lake in the Town of Poland. Both ponds are mesotrophic and hydrologically connected by a thoroughfare and consequently share the same fish community, although superior late summer water quality in Middle Range Pond sustains a wild population of lake trout (*Salvelinus namaycush*) generally not present in Upper Range Pond. A low-profile outlet dam on Middle Range Pond, and numerous tributaries (both perennial and intermittent) on both Middle and Upper Range ponds create attraction flows and migration pathways for gravid adult brown trout searching for spawning habitat in the fall.

Suitable late summer water quality on Middle Range Pond (Poland) extends well below the thermocline, with an oxygen deficiency limited to only the deepest areas of the lake. At 382 acres with a maximum depth of 66 feet, this is the largest study water. An abundance of forage fish (smelt and landlocked alewives) and very good late summer water quality provide very suitable conditions for brown trout management. Hatchery stocking programs maintain the brown, brook, and rainbow trout fisheries. Brown trout (325) and 650 rainbow trout (increased from 325 to 650 in 2008) are stocked annually to sustain a multi-age fishery. Although lake trout have not been stocked since 1987, a wild population has established and contributes to the recreational fishery. Fall yearling brook trout (300), along with a small number of retired brook trout brood are stocked each fall to provide a winter put and take fishery for indigenous trout. Self-sustaining populations of the following fish are also present: smallmouth bass, largemouth bass, white perch (*Morone americana*), yellow perch, chain pickerel, pumpkinseed sunfish, redbreast sunfish (*Lepomis auritus*), brown bullhead, American eel, and sculpin (*Cottus cognatus*), golden shiners, and other minnows (*Cyprinidae & Fundulidae)*. Brown trout, rainbow trout, brook trout, lake trout, smallmouth bass, and largemouth bass provide principle recreational fisheries.

Upper Range Pond is the second smallest study water, as well as the shallowest (maximum depth 38 feet). Water quality is similar to Crystal in that an oxygen deficiency develops below the thermocline, but remains suitable for managing brook and brown trout fisheries. Although limited natural reproduction of brook and brown trout have been documented in one inlet, inadequate spawning and nursery habitat and the existing competing fish assemblage preclude opportunities to manage for self-sustaining brown and brook trout fisheries. Consequently hatchery stocking programs maintain the trout fisheries. Brown trout (150) and 300 rainbow trout (increased from 150 to 300 in 2008) are stocked annually. Beginning in 2009, 400 fall yearling brook trout were stocked annually to enhance winter angling for indigenous trout. Other than lake trout, Upper Range Pond supports the same fish community described under Middle Range Pond.

METHODS

All study waters received annual allotments of New Gloucester strain hatchery brown trout that remained constant over the three year study period[2]. Existing stocking rates varied between study waters, reflecting differences in management and performance. Half of each scheduled brown trout stocking was planted in October (usual time of stocking) and the other half was reserved for stocking in December. On average, the trout were stocked 51 days apart (Table 1). Each stocking (October/December) was uniquely marked for field identification by removing one or more fins (Table 2).

Brown trout recruitment and contribution to the fishery on Crystal and Sabbathday Lakes was predominantly evaluated by interviewing recreational winter anglers on foot and by snowmobile and examining their harvested catch. Information collected during the interviews yielded catch rate, age, and growth information associated with each stocking event.

[2] Study water brown trout stocking rates: Sabbathday Lake = 1.03/acre (350 browns), Crystal Lake = 1.3/acre (250 browns), Upper Range Pond = 0.38/acre (150 browns), and Middle Range Pond = 0.89/acre (325 browns)

Table 1. Stocking Dates by Year and Water.

Year	**2007**			**2008**			**2009**			
	Mean Number of Days Between Stocking Events									
Water	Oct	Dec	Time (days)	Oct	Dec	Time (days)	Oct	Dec	Time (days)	**Mean**
Sabbathday Lake	16	11	56	16	10	55	19	10	52	54.3
Crystal Lake	16	11	56	16	10	55	19	10	52	54.3
Middle Range Pond	15	2	48	9	8	60	26	1	36	48
Upper Range Pond	15	2	48	9	8	60	26	1	36	48
Mean			52			57.5			44	**51.2**

Table 2. *Fin Clip Mark by Study Water and Month Stocked.

Water	U/M Ranges		Sabbathday		Crystal	
Month	Oct	Dec	Oct	Dec	Oct	Dec
Year						
2009	AD	**LV	AD	**LVAD	AD	***UM
2008	RV	RVAD	RV	RVAD	RV	RVAD
2007	BV	BVAD	BV	BVAD	BV	BVAD
2006	LV	LVAD	BV	BVAD	LV	LVAD

***Fin Clips: AD-adipose, RV-right ventral, LV-left ventral, BV-both ventrals, and UM-unmarked.** **changed from scheduled UM. ***Crystal was stocked by a hatchery unfamiliar with the study and inadvertently stocked UM marked fish.

A roving creel clerk interviewed[3] ice anglers on Crystal and Sabbathday lakes during January[4] of 2008, 2009, and 2010. Weekly surveys were scheduled for both weekend days and two other randomly selected fair-weather week days. Additional summer gill net and fall trap net sampling was undertaken in 2010 to increase the brown trout sample on Crystal Lake.

In 2009, brown trout were sampled from Middle and Upper Range ponds using gill nets (summer) and trap nets (fall). However, poor sampling success using these methods prompted the completion of a roving clerk creel survey in January of 2010, although only weekend days were surveyed when angler use was generally higher.

The observed catch of brown trout originating from each stocking event formed the basis of assessing contribution to the fishery. Angler catch rate estimates were calculated using Department analytical programs developed in SAS. Calculated differences in party catch rates

[3] The collection of brown trout harvest data on Sabbathday and Crystal lakes was incidental to data collection in support of a statewide assessment of "catchable" brook trout)
[4] Ice fishing season starts January 1st, and January supports the highest level of use of any winter month.

associated with each stocking were statistically tested ($p \leq 0.05$) using Nonparametric Wilcoxon Rank Sum two-sided analysis. Differences in cohort recruitment associated with each stocking were statistically assessed using Chi square testing.

RESULTS

A total of 179 study brown trout were examined across all 4 study waters (73% were collected from Sabbathday Lake). Fifty-nine percent originated from the December stocking and 41% originated from the October stocking. A more detailed discussion by study water follows.

Sabbathday Lake: A total of 130 study browns were examined by the survey clerk, of which 63% were stocked in December and 37% were stocked in October. In addition, December-stocked trout represented a higher percentage of the catch during each assessment year (Figure 2); on average 27% more. Mean party harvest rates for December-stocked trout (0.017 legal brown trout per hour, $n^{\text{angler interviews}}=448$) were 1.5 times higher than October-stocked trout (0.011 legal brown

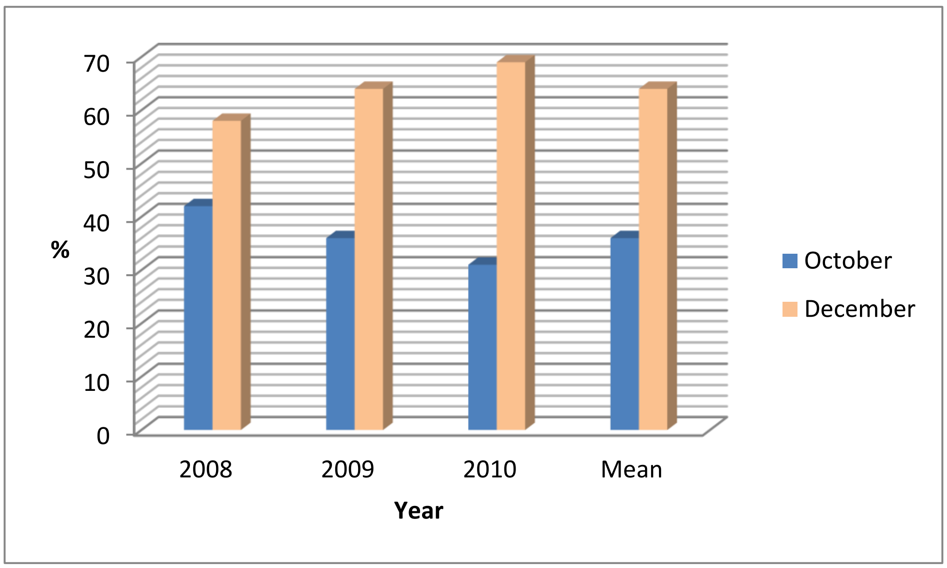

Figure 2. Percent of Harvest by Month and Year Stocked, Sabbathday Lake

trout per hour, $n^{\text{angler interviews}}=448$) and this difference was statistically significant (Wilcoxon rank sum, 2-sided, $p=0.0174$). An examination of individual age classes present in the harvest revealed a higher percentage of each age class was comprised of December-stocked fish (Table 3); on average 39% more. December-stocked trout contributed 25% more to the combined harvest of age 3 and 4 year old brown trout, which are the oldest and largest in the fishery. This difference was also found to be statistically significant ($X^2=33.802$, 1 d.f.; 2 sided $p<0.0001$).

Table 3. Contribution of October and December-Stocked Trout to Each Age Class Present in the Sabbathday Lake Winter Fishery, 2008 – 2010.

AGE	MONTH STOCKED		*% DIFFERENCE
	October-Stocked	*December-Stocked*	
2	7	14	(+)33
3	40	64	(+)23
4	1	4	(+)60
		Mean	**(+)39**

* "+" reflects increased contribution from December-stocked trout, "-" reflects a decrease from December-stocked trout.

Crystal Lake: Twenty nine study browns were examined by the survey clerk; 48% were stocked in October and 52% were stocked in December. Mean angler party harvest rates calculated for October and December-stocked trout were 0.005 and 0.006 legal brown trout harvested per hour, respectively ($n^{\text{angler interviews}}$=453). Unlike Sabbathday Lake, the difference in harvest was not statistically significant (Wilcoxon Rank sum, 2-sided, p=0.07149). An examination of individual age classes present in the harvest indicated no apparent relationship between age class and month stocked (Table 4). In addition, month of stocking did not significantly contribute to the development of age 3 and older cohorts (Table 4, X^2=0.360, 1 def.; 2 sided p=0.5485).

An additional 11 study browns were captured on Crystal Lake in gill and trap nets[5]. Pooling brown trout data across all capture methods ($N^{\text{survey, gill net, and trap net}}$= 40) suggests slightly more October-stocked trout (55%) were captured than December-Stocked trout (45%), a finding inconsistent with survey results for both Crystal and Sabbathday lakes.

Table 4. Contribution of October and December-Stocked Trout to Each Age Class Present in the Crystal Lake Winter Fishery, 2008 – 2010.

AGE	MONTH STOCKED		*% DIFFERENCE
	October-Stocked	*December-Stocked*	
2	3	1	-66
3	9	12	+14
4	1	1	0
5	1	1	0

* "+" reflects increased contribution from December-stocked trout, "-" reflects a decrease from December-stocked trout.

Middle Range Pond: Gill nets[6] were set over night on three occasions in July, August, and September of 2009, yielding two study browns (Table 5). One additional study brown was captured in traps nets[7] set in the fall of 2009. In 2010, winter anglers were surveyed during the

[5] Two 400' red monofilament gill nets (2 – 4" stretch mesh), each set for 18.9 hours on 8-12-10. Two trap nets fished 684.3 total hours from 10-27-10 to 11-10-10.
[6] 7-29-09: three 400' red monofilament gill nets (2 – 4" stretch mesh) fished a total of 61 hours, 8-5-09: three 400' red monofilament gill nets (2 – 4" stretch mesh) fished a total of 69.3 hours, 9-17-09: Two 400' red monofilament gill nets (2 – 4" stretch mesh) fished a total of 44.4 hours
[7] Two trap nets were fished a total of 626 hours between 11-2-09 (2nd net set on 11-4) and 11-16-09.

month of January[8] yielding one additional study brown. No water-specific analysis was completed for Middle Range Pond, given the small sample size (Table 5, n=4).

Upper Range Pond: Gill nets[9] were set over night on three occasions in July, August, and September of 2009, yielding five study browns (Table 5). No additional study browns were captured in traps nets[10] set in the fall of 2009. Then in 2010, winter anglers were surveyed on weekends during the month of January[11], but no harvested study browns were observed. No water-specific analysis was completed for the Upper Range pond, given the small sample size (Table 3, n=5).

Table 5. Brown Trout Sample Size by Water, Month Stocked, and Collection Method.

MONTH STOCKED/ COLLECTION METHOD									
	October - Stocked				*December - Stocked*				
WATER	**creel survey**	**gill net**	**trap net**	***subtotal***	**creel survey**	**gill net**	**trap net**	***subtotal***	***Total***
Sabbathday Lake	**48**	**0**	**0**	***48***	**82**	**0**	**0**	***82***	***130***
Crystal Lake	**14**	**1**	**7**	***22***	**15**	**0**	**3**	***18***	***40***
Middle Range Pond	**1**	**1**	**1**	***3***	**0**	**1**	**0**	***1***	***4***
Upper Range Pond	**0**	**1**	**0**	***1***	**0**	**4**	**0**	***4***	***5***
Total				***74***				***105***	***179***

DISCUSSION AND MANAGEMENT IMPLICATIONS

Fall yearling brown trout stocked in early December, approximately 7 weeks later than traditionally stocked in mid-October, contributed significantly more brown trout to the winter fishery on Sabbathday Lake, including a higher percentage of larger, older fish. Even though December-stocked brown trout were harvested from the fishery at a higher rate, they still contributed more to the harvest of each successive cohort present. It is speculated that sources of

[8] Surveys conducted on 9 weekend days: interviewed 161 anglers on Middle range pond and 225 anglers on Upper Range Pond.
[9] 7-29-09: three 400' red monofilament gill nets (2 – 4" stretch mesh) fished a total of 72.3 hours, 8-5-09: three 400' red monofilament gill nets (2 – 4" stretch mesh) fished a total of 69.1 hours, 9-17-09: three 400' red monofilament gill nets (2 – 4" stretch mesh) fished a total of 78.3 hours.
[10] Two trap nets were fished a total of 624 hours between 11-2-09 (2nd net set on 11-4) and 11-16-09.
[11] Surveys conducted on 9 weekend days: interviewed 161 anglers on Middle range pond and 225 anglers on Upper Range Pond.

post-stocking mortality for this particular water likely included wildlife predation and out migration (inlets/outlets), both of which may be associated with inshore spawning behaviors. These issues may have been mitigated by delaying stocking until after the spawning season. Stocking in December also reduced the opportunity for incidental mortality associated with catch and release fishing permitted on study waters between October 1 and December 31. This investigation did not assess the relative importance of the various possible factors responsible for diminished recruitment of October-stocked brown trout.

Unlike Sabbathday Lake, time of stocking did not appear to influence angler harvest opportunity on Crystal Lake. This apparent contradiction is deserving of additional discussion. Brown trout data collection on Crystal Lake (as well as Middle and Upper Range ponds) proved to be challenging and yielded a relatively small sample compared to Sabbathday Lake. A robust sample on Sabbathday Lake inspired confidence in statistical analysis results for that water, but this was not the case on Crystal Lake. Physical differences in watershed hydrology may partially account for differences in study findings. There are two large perennial inlets (Shaker Bog outlet and Mosquito Brook) and an unregulated outlet on Sabbathday Lake. Individual precipitation events and associated surface runoff directly influence inlet and outlet flows on Sabbathday Lake. The single inlet and unregulated outlet at Crystal Lake are best characterized by intermittent flows that offer very limited seasonal attraction and access for fish, particularly spawning trout. Differences in hydrology may suggest that the presence of stronger attraction flows on Sabbathday Lake concentrate newly stocked trout and increase vulnerability to post stocking mortality. Crystal Lake appears to be more strongly influenced by groundwater that reflects seasonal precipitation patterns that are less flashy and less responsive to individual precipitation events. As a result, post-stocking mortality related to spawning behavior is less likely to influence harvest success on Crystal Lake.

Stocking later in December may enhance winter angler catch rates and the availability of larger, older aged trout on some waters, but does pose some logistical and safety issues for hatchery personnel, including freezing equipment, icy work conditions, and the possibility of slippery snow and ice conditions on the roadways. These concerns warrant additional consideration while exploring strategies to enhance the success of Maine’s lacustrine brown tout fisheries.

CONCLUSIONS AND RECOMMENDATIONS

Investigating the influence of time of stocking on survival and return of stocked fall yearling brown trout to winter anglers was inconclusive on three of the four study waters examined due to small sample sizes. Only one study water (Sabbathday Lake) yielded a robust sample and high confidence in the analysis. Based on the Sabbathday Lake data, stocking fall yearling brown trout seven weeks later than currently practiced may increase survival and returns of legal trout to the winter fishery on some waters.

While the author speculates that the sexual maturity of stocked trout in the presence of small inlet tributaries and an actively discharging outlet may increase opportunity for predation and outmigration, the actual factors responsible for lost recruitment remain unknown. Future investigations should examine the timing and cause of post-stocking mortality to document the most significant sources of post stocking mortality and determine if these factors can be further mitigated. This type of research may best be addressed using radio telemetry.

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REFERENCES

Boland, J.J. 2001. Brown Trout Management Plan. Maine Department of Inland Fisheries and Wildlife. Augusta, Maine. 39pp.

Leary, Robb. 1999. September 14, 1999 letter to Russell Danner (Maine Department of Inland Fisheries and Wildlife) relating the results of electrophoretic analysis of the 1997 year class of New Gloucester State Fish Hatchery brown trout. University of Montana, Missoula. 15pp.

Marcus, M. D., W. A. Hubert, and S. H. Anderson. 1984. Habitat suitability index models: Lake Trout (Exclusive of the Great Lakes). U.S. Fish Wildl. Serv. FWS/OBS-82/10.84. 12 pp.

Pellerin, J.C. 2007. Rainbow Trout Experimental Stocking Program: Rainbow Trout and Brown Trout Field Comparisons. Final Report Series No. 07-01. Maine Department of Inland Fisheries and Wildlife. Augusta, Maine. 71pp.

Pellerin, J.C. 2007. Rainbow Trout Experimental Stocking Program: Rainbow Trout and Brook trout Field Comparisons. Final Report Series No. 07-02. Maine Department of Inland Fisheries and Wildlife. Augusta, Maine. 48pp.

Raleigh, Robert F., Laurence Zuckerman, and Patrick C. Nelson, 1986. Habitat suitability index models and instream flow suitability curves: brown trout, revised. U.S. Fish and Wildl. Serv. Biol. Rep. 82(10.124). 65pp.

Raleigh, R. F. 1982. Habitat suitability index models: Brook Trout. U.S. Dept. Int., Fish Wildl. Serv. FWS/OBS-82/10.24. 42pp.

SAS Institute, Inc. 1985. SAS User’s Guide: Basics. Version 5 Edition. Cary, North Carolina. 1290pp.

Warner, Kendell. 1972. Further Studies of Fish Predation on Salmon Stocked in Maine Lakes. The Progressive Fish-Culturist, Vol. 34, No. 4, p.217 - 221.